

### Claims

1. A method for the detection of the reception of a data frame in an input signal ( $y_{\text{OFF}}(n)$ ), said data frame comprising periodically repeated symbols at the beginning, comprising the steps of

- 5 a) sampling said input signal ( $y_{\text{OFF}}(n)$ ) with a predetermined sampling rate,
- b) generating a first signal ( $|J(k)|^2$ ) that is dependent on an autocorrelation of said input signal with a delayed copy of said input signal, and
- 10 c) detecting a plateau in said first signal ( $|J(k)|^2$ )
- d) generating an output signal that is indicative of detecting said plateau.

wherein said step of detecting a plateau comprises the steps of

- 15 c1) generating a differentiator signal ( $J_{\text{diff}}(k)$ ), which is dependent on the difference of a first sample of said first signal and a second sample of said first signal that was taken a first predetermined number of sampling periods earlier, and
- c2) detecting an absolute maximum of said differentiator signal ( $J_{\text{diff}}(k)$ ) within a second predetermined number of sampling periods.

- 20 2. The method according to claim 1, wherein said step c2) of detecting an absolute maximum comprises an instantaneous peak detection step and a step of detecting a falling slope in the differentiator signal ( $J_{\text{diff}}(k)$ ).

3. The method according to claim 2, wherein the instantaneous peak detection step and the group peak detection step are performed in parallel.
- 25

4. The method of claim 2 or 3, wherein the instantaneous peak detection step comprises a step of comparing the differentiator signal ( $J_{\text{diff}}(k)$ ) of a current sampling period with the differentiator signal ( $J_{\text{diff}}(k)$ ) of a next previous sampling period, and a step of saving the differentiator signal ( $J_{\text{diff}}(k)$ ) of the current sampling period to a register, given the condition that its value is larger than that of the differentiator signal ( $J_{\text{diff}}(k)$ ) of the previous sampling period.  
5
5. A method according to claim 4, comprising a step of incrementing a count index by one, given the condition that the value of said differentiator signal ( $J_{\text{diff}}(k)$ ) of said current sampling period is equal or smaller than that of said differentiator signal ( $J_{\text{diff}}(k)$ ) saved in said register.  
10
6. A method according to claim 5, comprising a step of generating an instantaneous peak detection signal indicative of the condition whether or not the count index has reached a predetermined count value.  
15
7. A method according to claim 1, comprising a step of detecting a falling slope in said differentiator signal ( $J_{\text{diff}}(k)$ ).  
20
8. A method according to claim 7, wherein detecting a falling slope comprises the steps of  
25
  - generating an accumulation signal that is dependent on the sum of said differentiator signal ( $J_{\text{diff}}(k)$ ) over a fourth predetermined number of consecutive sampling periods
  - comparing said current accumulation signal with the last previous accumulation signal representing without overlap said fourth predetermined number of consecutive earlier sampling periods
  - generating a group peak detection signal indicative of whether or not the value of said current accumulation signal is smaller than the value of said earlier accumulation signal.

9. A method according to claims 6 and 8, comprising a step of generating a maximum detection signal indicative of the condition
- that said instantaneous peak detection signal indicates that the count index has reached the predetermined count value and
  - 5 - that said group peak detection signal indicates that the value of said current accumulation signal is smaller than said value of said earlier accumulation signal.
10. A method according to any one of the preceding claims, wherein said output signal is indicative of the time of detecting said plateau.
- 10 11. A method according to any one of the preceding claims, wherein said method is used for detecting a data frame containing OFDM symbols.
12. A method according to any one of the preceding claims, wherein the input signal is amplified such that the power of the amplified input signal is in a predetermined power range.
- 15 13. A method according to claim 1 or 12, wherein the step of detecting a plateau in said first signal ( $|J(k)|^2$ ) is performed only if the first signal exceeds a predetermined threshold value.
14. A frame detector for detecting the reception of a data frame in an input signal ( $y_{\text{OFF}}(n)$ ), said data frame comprising periodically repeated symbols at the beginning, comprising
- 20
- a) a sampling unit adapted to sample said input signal ( $y_{\text{OFF}}(n)$ ) with a predetermined sampling rate
  - b) an autocorrelation unit adapted to transform said input signal ( $y_{\text{OFF}}(n)$ ) into a first signal ( $|J(k)|^2$ ) that is dependent on an autocorrelation of said input signal with a delayed copy of said
- 25 input signal, and

- c) a plateau detector, adapted to detect a plateau in said first signal ( $|J(k)|^2$ )
- d) an output unit adapted to generate an output signal that is indicative of detecting said plateau,

5 wherein said plateau detector is adapted to generate a differentiator signal ( $J_{\text{diff}}(k)$ ), which is dependent on the difference of a first sample of said first signal and a second sample of said first signal a predetermined number of sampling periods earlier, to detect an absolute maximum of said differentiator signal ( $J_{\text{diff}}(k)$ ) within a predetermined range of  
10 sampling periods, and to provide a signal indicative of detecting said absolute maximum to said output unit.

15. The frame detector of claim 14, wherein said plateau detector comprises a peak detection unit with

- a) a first detection unit connected to said input port and comprising a  
15 first memory unit, said first detection unit being adapted to
  - comparing said input signal ( $J_{\text{diff}}(k)$ ) received through said input port with a first entry contained in said first memory unit, and to
  - replacing said first entry by said input signal given the  
20 condition that the value of said input signal ( $J_{\text{diff}}(k)$ ) is larger than the value of said first entry,
- b) a second detection unit connected to said input port and comprising a second memory unit, said second detection unit being adapted to
  - generating an accumulation signal, that is dependent on the  
25 sum of a current input signal ( $J_{\text{diff}}(k)$ ) and of said fourth predetermined number of previous input signals ( $J_{\text{diff}}(k)$ ),

- comparing said accumulation signal with a second entry contained in said second memory for at least , and to
- replacing said second entry by said accumulation signal given the condition that the value of said accumulation signal ( $J_{\text{diff}}(k)$ ) is larger than the value of said second entry,

said peak detection unit being adapted to providing a peak detector output signal at its output port indicative of whether or not said first entry has been unchanged for a predetermined number of sample periods and said second entry has been changed in said current sampling period.

16. A synchronizing method comprising a step of detecting a frame in an input signal, wherein the frame detection step is performed with the method of at least one of the claims 1 to 11.
17. A synchronizing method according to claim 16, further comprising a step of estimating a relative frequency offset ( $f_e$ ) in an input signal ( $y_{\text{OFF}}(n)$ ) after said step of detecting a frame, wherein the estimating step comprises the steps of
  - a) estimating a coarse frequency offset ( $\beta$ )
  - b) estimating a fine frequency offset ( $\alpha$ ) in dependence of said estimated coarse frequency offset ( $\beta$ ).
18. The synchronizing method of claim 17, wherein the steps of estimating a coarse frequency offset ( $\beta$ ) or of estimating a fine frequency offset, or both steps, comprise a step of calculating a phase value of said first signal ( $|J(k)|^2$ ).

19. The synchronizing method of claim 17 or 18, wherein the step of estimating the frequency offset comprises a step of assigning a fine frequency offset value dependent on the value of the coarse frequency offset according to the following function:

$$\varepsilon = \alpha \quad ; \text{ if } (-0.25)/4 \leq \beta \leq (0.25)/4 \quad (\text{R1})$$

$$\varepsilon = \alpha \quad ; \text{ if } \alpha \geq 0 \text{ and } (0.25)/4 < \beta < (0.75)/4 \quad (\text{R2})$$

$$\varepsilon = 1 + \alpha \quad ; \text{ if } \alpha < 0 \text{ and } (0.25)/4 < \beta < (0.75)/4 \quad (\text{R3})$$

$$\varepsilon = 1 + \alpha \quad ; \text{ if } \beta \geq (0.75)/4 \quad (\text{R4})$$

$$\varepsilon = -1 + \alpha \quad ; \text{ if } \alpha \geq 0 \text{ and } (-0.75)/4 < \beta < (-0.25)/4 \quad (\text{R5})$$

$$\varepsilon = \alpha \quad ; \text{ if } \alpha < 0 \text{ and } (-0.75)/4 < \beta < (-0.25)/4 \quad (\text{R6})$$

$$\varepsilon = -1 + \alpha \quad ; \text{ if } \beta \leq (-0.75)/4 \quad (\text{R7})$$

20. The synchronizing method of claim 17 or 18, wherein the step of estimating the frequency offset comprises a step of assigning a fine frequency offset value dependent on the value of the coarse frequency offset according to the following function:

$$\varepsilon = \alpha \quad ; \text{ if } (-0.1)/4 \leq \beta \leq (0.1)/4 \quad (\text{R1})$$

$$\varepsilon = \alpha \quad ; \text{ if } \alpha \geq 0 \text{ and } (0.1)/4 < \beta < (0.9)/4 \quad (\text{R2})$$

$$\varepsilon = 1 + \alpha \quad ; \text{ if } \alpha < 0 \text{ and } (0.1)/4 < \beta < (0.9)/4 \quad (\text{R3})$$

$$\varepsilon = 1 + \alpha \quad ; \text{ if } \beta \geq (0.9)/4 \quad (\text{R4})$$

$$\varepsilon = \alpha \quad ; \text{ if } \alpha < 0 \text{ and } (-0.9)/4 < \beta < (-0.1)/4 \quad (\text{R5})$$

$$\varepsilon = -1 + \alpha \quad ; \text{ if } \alpha \geq 0 \text{ and } (-0.9)/4 < \beta < (-0.1)/4 \quad (\text{R6})$$

$$\varepsilon = -1 + \alpha \quad ; \text{ if } \beta \leq (-0.9)/4 \quad (R7)$$

21. The synchronizing method of one of the claims 16 to 20, further comprising a step of correcting the input signal by the estimated value.
- 5 22. The synchronizing method of claim 21, further comprising after said step of frequency offset correction a step of estimating the time of reception of at least one symbol contained in a received data frame (hereinafter symbol timing step).
- 10 23. The synchronizing method of claim 22, wherein the symbol timing step comprises a step of generating a crosscorrelation signal, which is dependent on the value of the crosscorrelation of the corrected input signal with a known reference signal, wherein the reference signal is a first section of long preamble symbols included in the data frame.
- 15 24. The synchronizing method of claim 23, wherein the reference signal is 32 samples long.
25. The synchronizing method of one of the claims 22 to 24, further comprising a step of estimating a reference channel.
- 20 26. The synchronizing method of claim 25, wherein estimating the reference channel comprises a step of performing a Fast Fourier Transform of a second section of the long preamble symbols included in the data frame.
27. A synchronizer device comprising a frame detector according to claim 14 or 15.
- 25 28. The synchronizer device of claim 27, further comprising a symbol timing unit adapted to generate a crosscorrelation signal, which is dependent on the value of the crosscorrelation of the corrected input signal with a known reference signal, wherein the reference signal is a first section of long preamble symbols included in the data frame.

29. The synchronizer device of claim 28, wherein the symbol timing unit comprises a crosscorrelation unit with a number of multipliers for complex numbers, and wherein at least one multiplier is made of a combination of XNOR-gates, inverter gates and adders.
- 5 30. The synchronizer device of one of the claims 27 to 29, wherein the frame detection unit and the symbol timing unit can be enabled or disabled individually.